China's Institutional Strength, Monetary Policy Coordination and Fiscal Crowding-in Effect

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Abstract: *As two main tools of macroeconomic policies, coordination and conflict between fiscal and monetary policies have been paid considerable attention by researchers. Under a structural vector autoregressive model that incorporates fiscal and monetary policies, this paper analyzes the monetary policy response to fiscal shocks. Our study finds that during the occurrence of a fiscal shock, the growth rate of broad money supply M2 substantially increased, indicating the adoption of an expansionary monetary policy by the monetary authority to fiscal policy expansion. Based on this empirical finding, this paper improves the dynamic stochastic general equilibrium model to investigate the fiscal policy effects under China's monetary policy coordination. Our analysis shows that monetary policy coordination will significantly boost the economic stimulus effect of fiscal policy, generating a fiscal crowding-in effect. From the perspective of China's institutional strength, this conclusion offers a theoretical explanation on the empirical fact of the fiscal crowding-in effect uncovered in the research literature, and offers a policy reference for making the proactive fiscal policy more efficient and effective. This paper suggests that China's policymakers give full play to the country's institutional strength by coordinating fiscal and monetary policies for high-quality economic development.*

Keywords: *Fiscal policy, monetary policy rules, monetary and fiscal policy coordination, fiscal multiplier*

JEL Classification Code: E62, H50, E60

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1. Introduction and Literature Review

With the emergence of Keynesianism in the 1930s, fiscal policy has become an important instrument of macroeconomic regulation for governments. By regulating government spending and taxation, fiscal policy has played a pivotal role in ironing out economic volatility and ensuring steady economic growth. With escalating China-US trade frictions and economic uncertainties since the global outbreak of COVID-19 pandemic, governments have once again turned their eyes to fiscal policy. In 2020, the Chinese government raised its general public budgetary deficit rate from 2.8% to 3.6% and issued various government bonds worth a total of 8.5 trillion yuan. China's Central Economic Work Conference of 2020 called for improving the quality, effectiveness and sustainability of the proactive fiscal policy and maintaining a proper spending intensity to support strategic priorities. It has set a clear principle to maintain a proactive fiscal policy as an instrument for macroeconomic regulation and reaffirmed the

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government's resolve to stabilize the economy. Interactions between the fiscal policy and the economy, the policy transmission mechanism and the identification of key factors for the fiscal policy to produce desirable effects have become questions of common concern for policymakers and economists.

For a quantitative analysis of fiscal policy effects, quite a few literature studies have focused on estimating the fiscal multiplier, i.e. the increase in total output by a certain number of units as a result of each unit of increase in government spending. Ramey (2011a) summarized empirical research results based on data from Western countries, and estimated the fiscal multiplier to be in the range between 0.8 and 1.5. In recent years, Chinese academics have also carried out extensive empirical research on China's fiscal multiplier. Based on the structural vector autoregression (SVAR) and provincial-data panel regression research, Wang and Wen (2019) found that China's short-term fiscal multiplier could reach 2.7, and long-term fiscal multiplier was as much as 4.9. Zhang *et al*. (2019) also found China's short-term fiscal multiplier to be significantly greater than 1 and long-term fiscal multiplier to be greater than 3 with pro-cyclical characteristics.

Referencing the fuzzy regression discontinuity (FRD) approach, Li and Li (2018) estimated the local fiscal multiplier for China's county-level governments to be significantly greater than 1 using the institutional design for transfer payment to ethnic regions. Li and Zhou (2021) identified exogenous government spending volatility based on change in transfer payment following the change of the term of office at central government ministerial agencies, and estimated China's fiscal multiplier to be roughly 1.56. In addition, Shi and Fukushige (2015), Jeong *et al*. (2017) and Zhang (2020) found China's fiscal multiplier to be significantly greater than 1. Moreover, Guo *et al*. (2016) estimated China's intergovernmental transfer payment multiplier to be 0.6 using the instrumental variable method based on the transfer payment system for poor counties. However, this method is limited to estimating the fiscal spending effect for economically backward regions and cannot be applied nationwide.

Obviously, the above methods have led to different estimates of China's fiscal multiplier. Yet on the whole, the estimated results tend to be large and significantly greater than 1 in most studies. In addition, the fact that the long-term multiplier is greater than short-term multiplier suggests that fiscal spending has generated a crowding-in effect that spurred economic activity in the private sector. A related question is which factors are at play for China's fiscal policy to deliver desirable effects? What is the transmission mechanism for fiscal policy to pull economic activity in the private sector?

A dilemma for theoretical economists is that the standard economics model cannot explain the fiscal crowding-in effect. More fiscal spending naturally leads to an increase in current or future taxation, thus generating a negative wealth effect that crowds out household consumption. In both the standard neoclassical economics model and the New Keynesian model, therefore, fiscal spending cannot generate a crowding-in effect on private consumption, which makes the standard theoretical models unable to explain the empirical results. As such, economists had to revise the standard model to incorporate a mechanism for fiscal spending to drive household consumption for a better explanation of real-world economic operation. For instance, Galí *et al*. (2007) introduced rule-of-thumb consumers, who spend their current labor income in each period without making any intertemporal optimal decisions and have a high marginal propensity to consume. Galí *et al*. (2007) verified that total consumption in the household sector could have been crowded in as long as numerous such households exist in the economy. Complementarity between government consumption and household consumption is also a possible factor of the fiscal crowding-in effect. When such complementarity is introduced, more government spending may drive household consumption (e.g. Bouakez and Rebei, 2007; Guo and Tian, 2014). Furthermore, Zubairy (2014) uncovered that an increase in government spending may drive household consumption after introducing deep consumption habits. Considering that the monetary policy is subject to the zero lower bound (ZLB) after the global financial crisis, fiscal policy may effectively stimulate household demand. Moreover, Corsetti *et al*. (2012) noted that when households forecast fiscal spending to decrease below the long-term trend after the end of a stimulus policy, i.e. fiscal spending reverses, the

fiscal multiplier of short-term fiscal stimulus tends to be more significant.

In light of the above theoretical models, it is not hard to discover that existing theories either require strong assumptions (e.g. existence of numerous irrational individuals in the economy, strong complementarity between public goods and private goods, and deep consumption habits) or are inconsistent with China's reality (e.g. nominal interest rates subject to the zero lower bound and reversal of fiscal spending) and cannot explain China's economic phenomena. Given that extensive empirical research has shown that China's fiscal policy has a significant crowding-in effect on economic activity in the private sector, this paper aims to offer a theoretical explanation of the underlying mechanism. Such work not only is significant for the development of economic theory, but also serves as reference for policymakers to have a clear view of the policy transmission mechanism and identify appropriate policies for informed decision-making.

Coordination and conflict between monetary policy and fiscal policy as the two pillars of macroeconomic regulation have been the focal point of attention for policymakers and academics. In many countries, fiscal and monetary authorities engage in strategic interactions to decide on policy options with inconsistent goals that may affect social welfare. Unlike those countries, People's Bank of China and Ministry of Finance are both under the State Council, and monetary and fiscal policymakers are both tasked with the mandate to serve the real economy under the central government's leadership. This institutional strength provides a greater possibility for fiscal and monetary policy coordination. Theoretical research indicates that compared with independent fiscal and monetary policymaking, fiscal and monetary policy coordination is more likely to enhance policy effects.

For instance, Woodford (2011) noted that the economic stimulus effect of fiscal policy is subject to the degree of monetary policy counter-cyclicality. During a fiscal expansion, an expansionary monetary policy helps enhance the effectiveness of fiscal policy. According to Galí (2020), when the central bank finances for fiscal policy by creating money, the expansionary fiscal policy may generate a significant economic stimulus effect. According to Li (2021), monetary and fiscal policies both have an effect on money circulation, which provides the possibility and necessity for policy coordination.

Based on China's institutional strength, this paper explains the fiscal crowding-in effect uncovered in the empirical research from the perspective of monetary and fiscal policy coordination, and identifies the critical factors of policy effectiveness by unravelling the policy transmission mechanism. This paper attempts to answer the following three questions: (1) Is China's monetary policy coordinated with or relatively independent from its fiscal policy? (2) If it is coordinated with fiscal policy, what is the degree of such policy coordination? (3) How does monetary policy coordination contribute to fiscal policy effectiveness? Can it explain the crowding-in effect of China's fiscal policy?

To answer the above questions, this paper introduces the SVAR model that incorporates both fiscal and monetary policies, and referencing Blanchard and Perrotti (2002) and Bjørnland and Leitemo (2009), investigates monetary policy response to the fiscal policy by applying long-term and short-term identification assumptions at the same time. Results indicate that China's monetary authorities have adopted an expansionary monetary policy during fiscal spending expansion, i.e. empirical results suggest that the monetary policy is coordinated with fiscal policy. This paper introduces such empirical research results into the DSGE model. Fiscal factor is introduced into monetary policy rules for the fiscal authority to adopt an expansionary monetary policy to coordinate with fiscal policy. Based on the estimation of model parameters with the Bayesian approach, the estimated values of relevant model parameters reflect the degree of coordination between China's monetary policy and fiscal policy, which answers the second question. Policy simulation and counterfactual tests of the model are performed to examine the effect of monetary policy coordination on fiscal policy. Our study finds that monetary policy coordination is a major factor behind the large fiscal multiplier. The model specification and parametric estimation in this paper may explain the puzzle of China's large fiscal multiplier. Based on the above conclusions, proactive communication and coordination between monetary and fiscal policy authorities

represent an effective means to improve the efficiency and effectiveness of the proactive fiscal policy.

Compared with existing studies, this paper offers the following contributions: (1) Coordination between China's monetary and fiscal policies is verified. Most existing studies have separately analyzed the economic effects of monetary policy or fiscal policy without empirically investigating monetary and fiscal policy coordination following a stringent method of identification. (2) Fiscal factor is introduced into the monetary policy rules of the DSGE model to improve macroeconomic modelling based on the characteristics of China's economy and further advance academic research on China's monetary policy rules. Most existing studies on China's monetary policy rules have focused on estimating and comparing quantitative, price or mixed policy rules, e.g. Ma (2011) and Wang *et al*. (2017). Yet this paper investigates the size of China's monetary policy from a multi-objective perspective of monetary policy. (3) A theoretical explanation on the fiscal crowding-in effect is offered based on China's reality. Existing explanations on the fiscal crowding-in effect (e.g. Galí *et al*., 2007; Woodford, 2011; Corsetti *et al*., 2012) either require a strong assumption or are inconsistent with China's economic reality. By means of data mining, this paper verifies the characteristics of the Chinese system and introduces empirical findings into the model to explain the fiscal crowding-in effect. (4) The interactive transmission mechanism between fiscal and monetary policies is further clarified to provide reference for informed policymaking and offer a viable path for increasing the efficiency and effectiveness of the proactive fiscal policy. Notably, the fiscal and monetary policy transmission mechanism put forth in this paper, though inspired by Woodford (2011) and Galí (2020), is not subject to the ZLB. Instead, it is a new mechanism based on the characteristics of the Chinese system. Existing studies have offered theoretical suggestions on fiscal policy formulation from various perspectives (e.g. Guo, 2018; Li and Tian, 2021). This study has further advanced research progress in this field.

The remainder of this paper is structured as follows: Part 2 examines the empirical facts of how China's monetary policy influences its fiscal policymaking. Part 3 creates the DSGE model. Part 4 is parametric calibration and estimation. Part 5 is the impulse response analysis and fiscal multiplier estimation; Part 6 is conclusions and policy implications.

2. Empirical Facts

This section aims to examine China's monetary policy response to its fiscal policy and analyze whether China's monetary policy is coordinated with or independent from fiscal policy. In terms of the analytical strategy, this paper employs the SVAR model that incorporates fiscal and monetary policy variables, and referencing Blanchard and Perrotti (2002), Bjørnland and Leitemo (2009), imposed both short-term and long-term assumptions to identify policy shock.

2.1 Data Source and Variable Selection

Based on the research objective, this paper introduces the quarterly data of five primary variables into the model, including GDP (y), government spending (g), quarterly growth rate of nominal money supply (M2), inflation (π), and the balance of loans from financial institutions (Loan), for the period from Q1 1995 to Q4 2017 with all data from Chang *et al*. (2016).

In this paper, total government spending is measured by the sum between government consumption spending and the total amount of government fixed asset formation, and deflates government consumption and investment spending by consumer price index (CPI) and investment price index to obtain corresponding real variables, which are added up into real total government spending. This paper also uses GDP deflator to deflate GDP and the balance of loans from financial institutions to arrive at the real values. Inflation rate is calculated with the consumer price index (CPI). Since Chang *et al*.'s (2016) data are seasonally adjusted, this paper takes logarithms of the above variables before analysis and extracts periodic components after removing linear and secondary temporal trends.

2.2 Identification of the SVAR Model

Let $Y_t=(g_t, y_t, loan_t, \pi_t, m2_t)'$ denote the vector employed in the vector autoregressive (VAR) model, and the places of elements in parentheses denote the order of variables in the model. In this paper, the VAR model is expressed in the following form:

$$Y_t=B(L)Y_t+v_t$$

Where, $B(L)$ is lag operator, v_t is a 5 × 1 vector that denotes statistical residual, from which the researcher needs to identify mutually orthogonal structural shock ε_t. Normally, it is assumed that the structural shock can be expressed as a linear combination of statistical residuals, i.e. $v_t=C\varepsilon_t$, where $CC'=V$ and $Ev_tv_t'=V$. To identify the matrix C, the standard deviations of ε_t is generally standardized to be 1. Next, an identification assumption needs to be imposed to Vector C to identify the impact of structural shock.

In the research literature on the identification of fiscal shocks, the short-term identification assumption put forth by Blanchard and Perrotti (2002) is widely influential. They point out that due to such reasons as the fiscal system, there is a lag in the response of the fiscal spending variable to the macroeconomic variable, making the case for an assumption that the short-term response of the fiscal variable to the economic variable is zero. When this paper puts the government spending variable before all other variables, this short-term identification assumption is reflected in the elements of the first row of C matrix all being zero except the first column. This chimes with the way in which the research literature, e.g. Guo (2018), employed the Choleski decomposition method to identify fiscal policy shock.

In the Choleski decomposition, all the elements at the upper right corner of C matrix's diagonal line are zero. Different from the research literature, the VAR model in this paper has also introduced the monetary policy variable represented by M2 growth rate, together with inflation rate as an economic variable that has short-term interactions with the monetary policy. Hence, it cannot assume that the short-term response between inflation and monetary policy is zero, i.e. elements in the fourth and fifth columns of C matrix are not zero. After the imposition of short-term identification assumption, the structure of C matrix becomes as follows:

$$C=\begin{bmatrix} C_{11} & 0 & 0 & 0 & 0 \\ C_{21} & C_{22} & 0 & 0 & 0 \\ C_{31} & C_{32} & C_{33} & 0 & 0 \\ C_{41} & C_{42} & C_{43} & C_{44} & C_{45} \\ C_{51} & C_{52} & C_{53} & C_{54} & C_{55} \end{bmatrix}$$

To fully identify C matrix, this paper also needs to impose an additional identification assumption. Referencing Bjørnland and Leitemo (2009) and based on the principle of long-term monetary neutrality, this paper assumes the long-term impact of short-term monetary policy shock on inflation to be zero. This long-term identification assumption can be realized by specifying the Row 4 Column 5 elements of matrix $(1-B)^{-1}C$ to be zero, where, $B=B(1)+B(2)+\ldots+B(p)$, and p is the lag order of the VAR model. According to the AIC standard, the lag order for the benchmark model in this paper is 5.

By simultaneously imposing short-term and long-term identification assumptions, this paper jointly incorporates fiscal and monetary policy variables into the SVAR model to identify the effects of fiscal policy shocks on the monetary policy variable and other macroeconomic variables.

2.3 Impulse Response

Figure 1 is the impulse response to each unit of fiscal policy shock. As can be seen from the chart, when government spending expanded, GDP sustainability increased, peaking in the 11th quarter, with long-term effects lasting for as much as six years. More importantly, M2 growth increased sharply by 3% during a fiscal expansion and 10% in the second quarter following the fiscal shock, and the expansionary trend lasted for a full year. The implication is that the monetary authority had adopted

an easy monetary policy in coordination with the fiscal expansion. The expansionary monetary policy resulted in a brief uptick of inflation, but the impact of fiscal shock on inflation diminished to zero two years later. The balance of loans from financial institutions also expanded in the first year after the fiscal shock, but started to shrink afterwards. This reflects a lending spree by financial institutions under the fiscal expansion's effect and a swift recovery of loans as the fiscal policy returned to normality.

To examine the responses of private consumption and investment and maintain a sufficient freedom of the SVAR model, this paper observes the impulse response of each variable by substituting the variable once at a time referencing Ramey (2011b). Specifically, this paper substitutes the balance of loans from financial institutions in the benchmark model with private consumption and investment, respectively, while keeping other variables. As can be seen from the chart, both private consumption and investment have a positive response, reflecting the crowding-in effect of fiscal spending. This result is consistent with the empirical findings in the research literature.

To test the robustness of the above results, this paper further performs the following robustness test: (1) The number of lags is adjusted to be two, three and four; (2) total government spending is substituted into government consumption spending and government investment spending; (3) HP filter method is utilized to detrend the data. The impulse response functions obtained from the above robustness test are similar to those of the benchmark model of this paper. As such, the empirical result of this paper is robust. That is to say, China's monetary policy is coordinated with fiscal policy, and money supply is increased in respond to a fiscal expansion.[1]

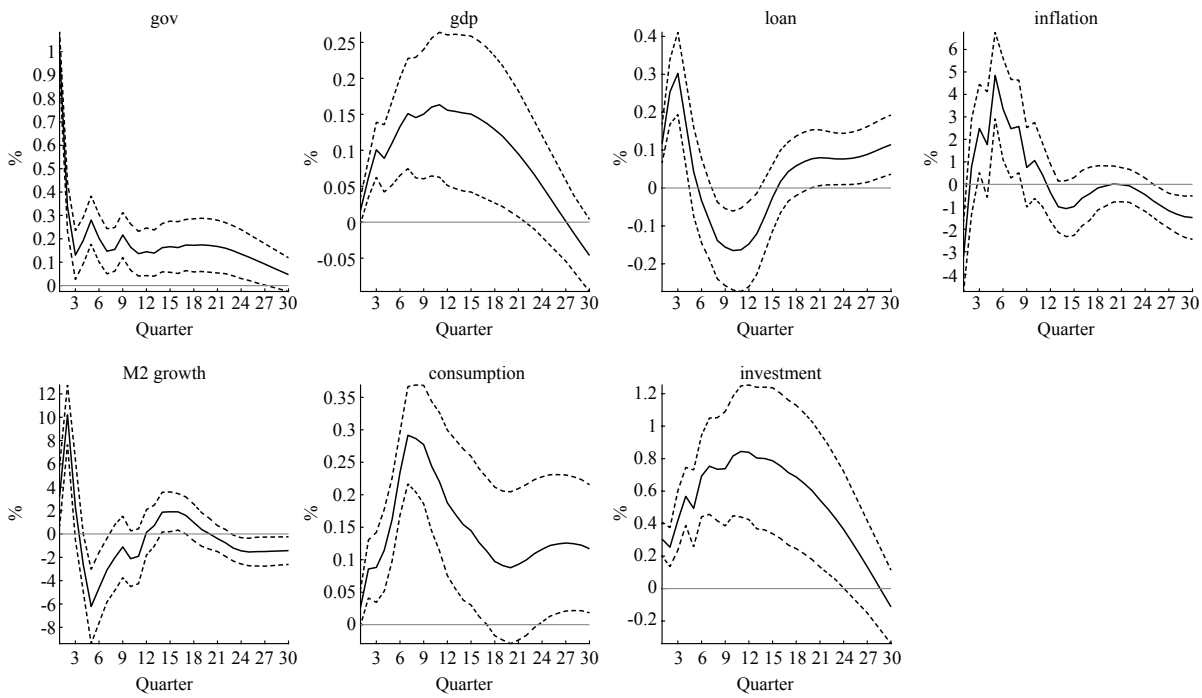

Figure 1: Impulse Response to Fiscal Spending Shocks

Note: The solid line represents percentage deviation from steady state and the dashed lines represent the 68% confidence interval.

[1] In addition, the impulse response of fiscal spending to monetary policy shocks is also examined in this paper. Results indicate that when M2 growth increases by 1%, there is no significant change in fiscal spending in the current period of fiscal shock, which is followed by a minor increase, and the overall level of volatility is relatively small. Obviously, monetary policy is more significantly coordinated with fiscal policy rather than the other way around.

Based on the above empirical findings and the results of Woodford (2011) and Galí (2020), this paper considers that monetary policy coordination with fiscal policy is an important reason for China's fiscal policy effectiveness. To verify this view, Section 3 introduces the response of monetary policy to fiscal policy in the DSGE model for an analysis of how such policy coordination contributes to China's fiscal policy effectiveness.

3. Model Specification

This paper creates a model referencing the general New Keynesian DSGE framework employed by Smets and Wounters (2007) and Jian *et al*. (2011). Our model adopts the standardized structure found in the research literature for the dynamic optimization behaviors of households and manufacturers. The depiction of government behaviors, including monetary and fiscal policies, is an innovation of this paper. Our model introduces real frictions such as consumer habits, capital efficiency and investment adjustment cost, and assumes workers' wage and commodity price to be sticky.

3.1 Households

It is assumed that continuous households exist in the economy, and each household is denoted by a continuous index $j\in(0, 1)$. Households maximize the lifetime utility discount by choosing consumption c_{jt}, real amount of money in possession M_{jt}/P_t, and labor hours l_{jt}, and MIU utility function is expressed as:

$$E_0\sum_{t=1}^{\infty}\beta^t\left[log(c_{jt}-hc_{t-1})+u_t log\left(\frac{M_{jt}}{P_t}\right)-\varphi\frac{l_{jt}^{1+\sigma l}}{1+\sigma l}\right]$$

Where, $\beta\in(0, 1)$ is discount rate; $h\in(0, 1)$ is the intrinsic consumer habit formation factor; c_{t-1} is the real total consumption of the entire economy during period $t-1$ and denotes consumer habits; φ depicts the utility weight of consumer leisure; l_{jt} is the labor supply of households; σ_l is the inverse of the Frisch elasticity of labor supply. M_{jt} is the amount of money held by household j, and P_t is consumer price index. u_t is the utility weight of the real balance of money in possession, and ε_t^u is monetary demand shock, and $log(u_t)$ conforms to the corresponding AR (1) process: $log(u_t)=(1-\rho_u)log(u)+\rho_u log(u_{t-1})+\varepsilon_t^u$.

Consumer j satisfies the following budgetary constraint:

$$c_{jt}+I_{jt}+\frac{M_{jt}}{P_t}+\frac{B_{jt}}{P_t}=\frac{W_{jt}l_{jt}}{P_t}+[r_t v_{jt}-\mu_t^{-1}\phi_t(v_{jt})]k_{jt-1}+\frac{M_{jt-1}}{P_t}+\frac{R_{t-1}B_{jt-1}}{P_t}-T_t$$

Real investment of the household in capital k_{jt} is I_{jt}, which offers an investment return of r_t, v_{jt} is capital utilization rate, and $\mu_t^{-1}\phi(v_{jt})$ is the real cost of use for each unit of capital, which satisfies $\phi(v_{jt})=\gamma_1(v_{jt}-1)+\frac{\gamma_2}{2}(v_{jt}-1)^2$, where $\gamma_1\geq 0$, $\gamma_2\geq 0$, and u_t is the investment-specific technology shock for the adjustment of relative capital price; the household purchases one series of bond B_{jt}, which offers a risk-free nominal return of R_t in period $t+1$; T_t is a package of taxes collected by the government. $log(u_t)$ conforms to the corresponding AR(1) process: $log(u_t)=(1-\rho_u)log(u)+\rho_u log(u_{t-1})+\varepsilon_t^u$.

The capital accumulation equation is:

$$k_{jt}=(1-\delta)k_{jt-1}+u_t[1-S\left(\frac{I_{jt}}{I_{jt-1}}\right)]I_{jt}$$

Capital depreciation rate is δ, S(·) is the capital adjustment cost function, $S\left(\frac{I_{jt}}{I_{jt-1}}\right)=\frac{\iota}{2}\left(\frac{I_{jt}}{I_{jt-1}}-\Lambda\right)^2$, which satisfies $S'(1)=S(1)=0$, and $S''(1)>0$. Where, $\iota\geq 0$, and Λ is the growth rate of investment along an equilibrium growth path.

In the equilibrium state, household consumption and asset possession are homogeneous, but wage and working hours are heterogeneous. Total nominal wage W_t is given, and the same optimal wage W_t^* is specified. The model introduces nominal wage stickiness and employs the Calvo pricing mechanism, assuming that household j has a probability of $1-\theta_w$ in each period to set wage W_{jt}; otherwise, wage is

adjusted by the inflation rate of the economy, $W_{jt}=W_{jt-1}(\pi_{t-1})^{\gamma w}(\bar{\pi})^{1-\gamma w}$, i.e. W_{jt-1} is exponentiated using the average geometric weight of nominal wage growth in the previous period and at the equilibrium point, and parameter $\gamma_w \in (0, 1)$ controls for the degree of partial exponentiation.

3.2 Firms

There are two categories of firms in the market, i.e. intermediate goods firms and final good firms. It is assumed that the intermediate good firm $i \in (0, 1)$ makes the intermediate good y_{it} as an input of final good y_t. Final good firms are in perfect competition, i.e. the profit of final good firms is zero and satisfies the Dixit-Stiglitz production function. Total demand for the final good is denoted by the aggregation of differentiated products made by various intermediate goods firms.

$$y_t^d=\left(\int_0^1 y_{it}^{\frac{\zeta_t-1}{\zeta_t}}di\right)^{\frac{\zeta_t}{\zeta_t-1}}$$

Where, y_t^d is total demand for the final good, y_{it} is the output of intermediate good from firm i as the factor input of the final good, ζ_t is the substitution elasticity of different intermediate goods over time, and $log(\zeta_t)$ conforms to the corresponding AR(1) process: $log(\zeta_t)=(1-\rho_\zeta)log(\zeta)+\rho_\zeta log(\zeta_{t-1})+\varepsilon_t^\zeta$.

The intermediate good market is in monopolist competition, and firm i satisfies the Cobb-Douglas production function:

$$y_{it}=(v_t k_{it-1})^{\alpha}(A_t k_{it})^{1-\alpha}-\Omega$$

In period t, there are two input factors, including capital k_{it} leased by firm i and labor input l_{it} for firm i. α is the capital share of income, and denotes the capital output elasticity coefficient. Accordingly, $1-\alpha$ is the technology and labor output elasticity coefficient, Ω is the fixed cost of production, and A_t is the neutral technology shock of labor productivity, whose growth rate $z_t=\log(A_t/A_{t-1})$ conforms to the corresponding AR(1) process: $z_t=(1-\rho_z)log(\gamma)+\rho_z z_{t-1}+\varepsilon_t^z$, where, γ is growth rate of A_t along the equilibrium growth path.

Household labor supply to intermediate goods firms satisfies the following equation:

$$l_t^d=\left(\int_0^1 l_{jt}^{\frac{\eta-1}{\eta}}dj\right)^{\frac{\eta}{\eta-1}}$$

Where, $\eta \in (0, +\infty)$ is the elasticity of substitution between different sorts of labor force.

Intermediate goods firms cannot determine wage W_t, but may choose product price P_{it} to realize the optimization. This paper introduces the Calvo-style price stickiness and specifies the optimal price to be P_t^*, and firm i has a probability of $1-\theta_p$ to adjust the price. If price cannot be re-optimized, it is adjusted by the inflation rate of the economy, i.e. $P_{it}=P_{it-1}(\pi_{t-1})^{\gamma p}(\bar{\pi})^{1-\gamma p}$, where $\gamma_p \in (0, 1)$, $\pi_t=P_t/P_{t-1}$.

3.3 Government

(1) Government budgetary constraint. Depiction of the government sector marks an innovation of this paper. First, referencing Galí (2020), the government makes overall considerations for the fiscal and monetary authorities, and the fiscal authority collects taxes, issues bonds, and supports government spending and service of government debt in the previous period via seigniorage. Hence, government budgetary constraint is expressed as follows:

$$\frac{B_t}{P_t}+\frac{M_t}{P_t}+T_t=g_t+\frac{R_{t-1}B_{t-1}}{P_t}+\frac{M_{t-1}}{P_t}$$

Where, g_t is real government spending[2], B_t is nominal government debt, T_t is real lump-sum tax, M_t is money supply, P_t is price level, and R_{t-1} is nominal interest rate.

[2] Research shows that government investment may drive economic activity in the private sector by raising firm productivity. To explain the transmission mechanism more clearly and avoid interference of other factors, this paper makes no distinction between government investment and government consumption.

Obviously, an increase in government spending relies on not only government tax finance, but seigniorage and government bond issuance. Arrangement of the above equation gives us:

$$g_t=T_t+m_t-\frac{m_{t-1}}{\pi_t}+b_t-\frac{R_{t-1}b_{t-1}}{\pi_t}$$

Where, m_t is real money supply, and b_t is real government bond issuance.

(2) Taxation and fiscal spending. According to Galí *et al*. (2007), this paper sets government taxation as adjusted according to changes in government bonds in the previous period and government spending in the current period. Policy rule for lump-sum tax is expressed as follows:

$$T_t=\varphi_b b_{t-1}+\varphi_g g_t$$

Where, φ_b is the response of taxation to government debt (with a one-phase lag), and φ_g is the response of taxation to government spending. This equation suggests that when government spending increases, the government will raise lump-sum tax and partially finance for the increment of spending. Such an increase of taxation is one of the sources of the negative wealth effect of increased government spending[3], i.e. a reason for the crowd-out effect on private consumption.

Government spending is subject to exogenous shocks, and real spending satisfies the following equation:

$$\frac{g_t}{\bar{g}}=\left(\frac{g_{t-1}}{\bar{g}}\right)^{\rho g}\cdot exp(\varepsilon_t^g)$$

Where, $\bar{g}$ is the steady-state real government spending, and ρ_g reflects continuity of the impact of government spending. Greater ρ_g means a more lasting impact of exogenous government spending shocks.

(3) Monetary policy. The literature has discussed whether China's monetary policy is based on price or quantitative rules or hybrid rules. Since this paper employs data of 1995-2017, during which period China's monetary policy was primarily quantitative, we select money supply as the policy variable and set the growth rate of nominal money supply $\chi_t=M_t/M_{t-1}=(m_t/m_{t-1})\times\pi_t$ as the policy instrument, which satisfies the following policy rule:

$$\frac{\chi_t}{\bar{\chi}}=\left(\frac{\chi_{t-1}}{\bar{\chi}}\right)^{\rho\chi}\left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{-\gamma\pi}\left(\frac{y_t}{\bar{y}}\right)^{-\gamma y}\left(\frac{g_t}{\bar{g}}\right)^{-\gamma g}\right]^{1-\rho\chi}\cdot exp(\varepsilon_t^\chi)$$

In this quantitative monetary policy rules, the growth rate of nominal money supply is subject to not only inflationary and total output, but the direct effect of fiscal spending as well. According to our empirical research results, China's monetary authority adopted a strategy of coordination during fiscal spending expansions, as manifested in an increase of money supply. By making a reasonable improvement to the monetary policy rules, this paper introduces this empirical finding into the model to analyze how monetary policy coordination contributes to fiscal policy effectiveness. In the above monetary policy rules, γ_π, γ_y and γ_g measure the degrees of monetary policy response to variations in inflation, total output and fiscal spending. By estimating parameter γ_g in the following section, this paper may obtain the degree to which China's monetary policy is coordinated with fiscal policy. In addition, ρ_χ and ε_t^χ denote monetary policy continuity and monetary policy shock, $\bar{\chi}$, $\bar{\pi}$ and $\bar{y}$ respectively denote the steady states of nominal money supply growth rate, inflation and real GDP.

In the model, part of government spending increase may be financed by raising the lump-sum tax, and the other part of fiscal spending increase is financed by money. If the two financing methods are still insufficient to finance for the increase of government spending, the remainder has to be financed by the issuance of government bonds under the government budgetary constraint.

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[3] Another source of negative wealth effect is an increase of government liabilities, which means an increase of future taxation. It may also be regarded that an increase in taxation (in the current or a future period) is the main reason for the negative wealth effect of government spending.

3.4 General Equilibrium System

The baseline model consists of households, enterprises and the government. Households determine their own consumption, labor supply and capital allocation. Final good firms determine the demand for intermediate goods. Intermediate goods firms determine factor resource allocation and goods production. The government regulates the economy by implementing fiscal and monetary policies. In the general equilibrium, labor market, final product market and capital market in the economic model are simultaneously cleared.

4. Calibration and Estimation

This paper solves the model by logarithmic linearization. In this section, we will assign values to the model parameters by calibration and Bayesian estimation.

4.1 Calibration

In this paper, we follow consistent parametric values with those of research papers on China's economy. First, most literature studies have specified the value of discount factor β to be in the range of 0.98 and 1.00, e.g. Wang and Tian's (2014) 0.98, Liu's (2008) 0.985 and Wang *et al*.'s (2017) 0.993, and this paper specifies the discount factor to be 0.985. The capital share of income α in the production function of China's economy is usually higher than those of developed countries, e.g. Xu and Lin's (2011) 0.45, and is set as 0.45 in this paper. The quarterly depreciation rate of capital is specified as 0.035, i.e. annual depreciation rate is 14%. Ma (2011) set price and wage stickiness parameters θ_p and θ_w both at 0.60, noting that both the nominal price and wage rigidity in the Chinese market are moderate. Referencing Wang's (2010) elasticity of intermediate product substitution ζ set as 10 and Li and Liu's (2017) elasticity of labor substitution η set as 10, we set the parameter of capital cost equation γ_2 to be 0.001; as can be learned from the observable mean data, the steady-state ratio $\overline{g}/\overline{y}$ between government spending and output is 0.19, and the steady-state inflation rate $\overline{\pi}$ is 0.50 percentage points; from the mean ratio between the end-of-quarter balance of central government liabilities and GDP, the steady-state ratio between government debt and output $\overline{b}/\overline{y}$ is 2.44. Table 1 is a summary of parametric calibration values for this paper.

4.2 Bayesian Estimation: Data Explanation

In the Bayesian estimation process, this paper employs six observation variables, including real total output, real total private consumption, real total private investment, inflation rate, real government spending, and real money supply M2 with data between Q1 1995 and Q4 2017 from Chang *et al*. (2016). Among them, real total output is obtained by dividing nominal GDP by the GDP deflator; real total private consumption is obtained by dividing total nominal private consumption by the consumer price index (CPI); real total private investment is obtained by subtracting government fixed capital formation from total nominal capital formation and dividing the result by the fixed capital investment price index; inflation rate is calculated with the GDP deflator; real money supply is obtained by dividing broad money supply (M2) by GDP deflator; real government spending is real government consumption

Table 1: Calibrated Values of Some Model Parameters

β	α	δ	θ_w	θ_p	ζ	η	γ_2	$\overline{\pi}$	$\overline{g}/\overline{y}$	$\overline{b}/\overline{y}$
0.985	0.450	0.035	0.600	0.600	10.000	10.000	0.001	1.005	0.190	2.440

plus real government investment, where real government consumption is obtained by dividing nominal government consumption by CPI, and real government investment is obtained by dividing nominal government fixed capital by the investment price index of fixed capital. To ensure stationarity, all data are subject to seasonal adjustment and detrending (HP filter), and are converted to their logarithmic form based on model requirements.

4.3 Bayesian Estimation: Prior Distribution and Estimation Results

This section provides the prior distribution of each parameter and estimates relevant parameters following the Bayesian approach. For the prior distribution of various parameters, we primarily reference Wang (2010), He *et al*. (2013) and Wang *et al*. (2017). It is specified that intertemporal labor supply elasticity σ_l conforms to the gamma distribution with a mean of 1.00 and standard deviation of 0.50; consumption habit factor h conforms to the beta distribution with a mean of 0.50 and standard deviation of 0.15; both the exponential parameters γ_w and γ_p of optimal wage and price conform to the beta distribution with a mean of 0.50 and standard deviation of 0.15; capital adjustment cost parameter ι conforms to the normal distribution with a mean of 4.00 and standard deviation of 1.50; autoreggressive coefficient $\rho_x(x=g, u, \mu, \zeta, z)$ of each shock conforms to the beta distribution with a mean of 0.50 and standard deviation of 0.20, and the standard deviation of each shock $\sigma_x(x=g, u, \mu, \zeta, z, \chi)$ conforms to the inverse gamma distribution with a mean of 0.10; and smoothing factor of the monetary policy rules ρ_χ conforms to the beta distribution with a mean of 0.40 and standard deviation of 0.15.

The sign and magnitude of the monetary policy response coefficient determine the direction and preference of policy adjustment. Specifically, it needs to be ensured that the response coefficient of money supply growth to inflation and output is negative, and the response coefficient of money supply growth to government spending is positive. Based on Wang's (2010) parametric specification, under the price-based monetary policy rules, the coefficient of monetary policy to inflationary gap is 1.43, which is greater than 1, and its coefficient to the output gap is 0.23. Wang *et al*. (2017) also applied this rule to the quantitative monetary policy rules.

Hence, it is specified that the response coefficient of money supply to inflation γ_π conforms to the normal distribution with a mean of 1.50 and standard deviation of 0.15, and its response coefficient to output gap γ_y and response coefficient to government spending gap γ_g conform to the normal distribution with a mean of 0.25 and standard deviation of 0.05; in the fiscal policy rule, the response coefficient of taxation to national debt φ_b conforms to the beta distribution with a mean of 0.33 and standard deviation of 0.01, and its response coefficient to government spending φ_g conforms to the beta distribution with a mean of 0.26 and standard deviation of 0.01.

Table 2 summarises the prior distribution specifications and posterior distribution estimation results of parameters in this paper.

Most parametric estimation results in this paper are similar to those in the research literature. Notably, this paper introduces a new parameter γ_g, i.e. the response coefficient of monetary policy to fiscal spending, for which no reference can be found in the literature. This paper specifies that the response coefficient γ_g conforms to the normal distribution with a mean of 0.25 and standard deviation of 0.05. The mode of posterior distribution of the resultant parameter γ_g is 0.24 with a standard deviation of 0.05, and the posterior distribution's density is very different from that of prior distribution, which indicates that this parameter has been identified. The implication is that the monetary policy indeed has a positive response to the expansion of fiscal spending, i.e. the monetary authority coordinates with the implementation of fiscal policy by increasing money supply.

Table 2: Bayesian Estimation Results of Model Parameters

Parameter	Prior distribution				Posterior distribution		
	Type of distribution	Mean	Standard deviation		Mean	Mode	Standard deviation
σ_l	gamma	1.0000	0.5000	σ_l	1.2761	0.9941	0.7312
h	beta	0.5000	0.1500	h	0.7241	0.7272	0.0597
γ_w	beta	0.5000	0.1500	γ_w	0.6396	0.5971	0.0994
γ_p	beta	0.5000	0.1500	γ_p	0.8167	0.8279	0.0696
ι	normal	4.0000	1.5000	ι	5.4271	4.8887	1.0759
ρ_g	beta	0.5000	0.2000	ρ_g	0.5325	0.5190	0.0952
ρ_u	beta	0.5000	0.2000	ρ_u	0.4436	0.4158	0.1535
ρ_μ	beta	0.5000	0.2000	ρ_μ	0.0959	0.0638	0.0456
ρ_ζ	beta	0.5000	0.2000	ρ_ζ	0.7314	0.7285	0.0578
ρ_z	beta	0.5000	0.2000	ρ_z	0.1812	0.1632	0.0794
ρ_χ	beta	0.4000	0.1500	ρ_χ	0.7234	0.7466	0.0369
γ_π	normal	1.5000	0.1500	γ_π	1.4182	1.4272	0.1524
γ_y	normal	0.2500	0.0500	γ_y	0.2214	0.2340	0.0338
γ_g	normal	0.2500	0.0500	γ_g	0.2175	0.2350	0.0537
φ_b	beta	0.3300	0.0100	φ_b	0.3346	0.3298	0.0099
φ_g	beta	0.2600	0.0100	φ_g	0.2589	0.2598	0.0100
σ_z	inv_gamma	0.1000	2.0000	σ_z	0.0472	0.0474	0.0050
σ_μ	inv_gamma	0.1000	2.0000	σ_μ	0.0410	0.0400	0.0042
σ_ζ	inv_gamma	0.1000	2.0000	σ_ζ	0.3067	0.2970	0.0397
σ_u	inv_gamma	0.1000	2.0000	σ_u	0.7972	0.7847	0.2188
σ_g	inv_gamma	0.1000	2.0000	σ_g	0.0324	0.0324	0.0031
σ_χ	inv_gamma	0.1000	2.0000	σ_χ	0.0228	0.0228	0.0025

5. Impulse Response Analysis and Fiscal Multiplier Estimation

This section analyzes the fiscal policy effect of monetary policy coordination, especially the effect on the magnitude of fiscal multiplier.

5.1 Economic Effect and Mechanism of Fiscal Spending Expansion

To analyze the effect of monetary policy coordination on the fiscal policy's economic effectiveness, this paper compares the impulse response function of government spending in two scenarios: $\gamma_g>0$, i.e. the monetary policy has a direct response to a fiscal expansion; $\gamma_g=0$, i.e. the monetary policy does not have any direct response to fiscal expansion (monetary policy independence).

Figure 2 shows that in the presence of monetary policy coordination, the central bank will increase money supply amid an expansion of fiscal spending; it may also be observed that an increase in fiscal spending has a crowding-in effect on private consumption and investment, causing total output to increase continuously. In comparison, in the absence of monetary policy coordination, an increase in fiscal spending has a crowding-out effect on private consumption and investment, so that the positive response of total output to fiscal expansion only exists in the first few phases of policy expansion, and is swiftly followed by a contraction of total output. Judging by the impulse response of government debt-output ratio, since the expansion of money supply has increased seigniorage, fiscal policy expansion in the presence of monetary policy coordination will - instead of exacerbating government debt burden -

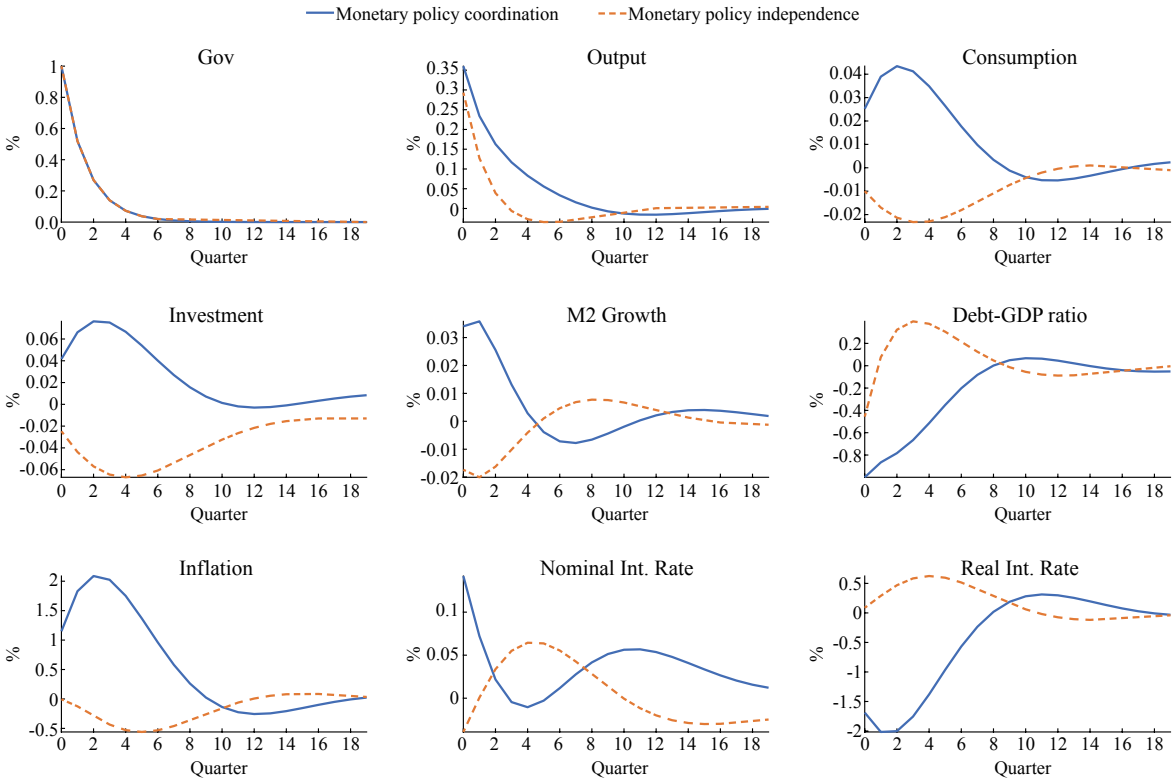

Figure 2: Impulse Response Function of Fiscal Spending Shocks

Note: Horizontal axis is quarter, and vertical axis is the percentage of variable change. The same is true for the following graphs.

reduce the government debt-output ratio in the short run. However, in the absence of monetary policy coordination, there will be a short-term increase in government debt level. Judging by the impulse response function of taxation and government debt, taxation and government debt will even decrease in the short term under the scenario of monetary policy coordination. Under the scenario of monetary policy independence, however, both will increase sharply.

The Chinese government has enacted proactive fiscal policies twice over the past two decades in 1998-2004 and in 2008, respectively. Judging by the effect of policy implementation, both proactive fiscal policies have helped China's economy cope with the economic shocks and recover swiftly from the Asian Financial Crisis and the global financial crisis. That is to say, the crowding-in effect of China's fiscal policy is highly consistent with the result from monetary policy coordination in this paper.

Notably, the Chinese government has followed a prudent monetary policy in lockstep with the implementation of a proactive fiscal policy since 2011. A proactive fiscal policy maintains economic stability and growth by means of such instruments as fiscal spending and taxation, and a robust monetary policy requires the growth rates of money supply and total social financing to keep abreast with nominal economic growth rate. Hence, money supply will increase amid economic growth arising from the proactive fiscal policy, which is an intended result of this policy combination. The study offers a theoretical basis for the scientificity of this policy combination.

Further, we may estimate the fiscal multiplier with the impulse response function. The fiscal multiplier can be divided into the impact multiplier $\Delta Y_t/\Delta G_t$ and the multi-periods cumulative multiplier $(\sum_{i=0}^{N}\beta^i\Delta Y_i)/(\sum_{i=0}^{N}\beta^i\Delta G_i)$, respectively, where ΔY_t and ΔG_t denote changes in real output and government spending, i.e. $\frac{\Delta Y_t}{\Delta G_t}=\frac{\hat{y}_t}{\hat{g}_t}\frac{\bar{y}}{\bar{g}}$.

Table 3: Comparison of Changes in the Fiscal Multiplier

	γ_g>0		γ_g=0	
	With capital cost	Without capital cost	With capital cost	Without capital cost
Impact multiplier	1.8822	1.1349	1.5317	0.9351
One-year multiplier	2.3589	1.3735	1.2348	0.7527
Two-year multiplier	2.6554	1.5025	0.8627	0.5319
Three-year multiplier	2.5706	1.5082	0.7489	0.4637
Four-year multiplier	2.4633	1.5213	0.7807	0.4517
Five-year multiplier	2.4364	1.5412	0.8211	0.4370

Table 3 reveals that when γ_g>0 i.e. monetary policy is coordinated with fiscal policy, both the impact multiplier and the cumulative multiplier are greater than those under the scenario of γ_g=0, and both of them are greater than 1, reflecting an increase in the economic stimulus effect of fiscal policy in the presence of monetary policy coordination. Notably, when γ_g=0, in the model with capital cost, firms may cope with the demand expansion by adjusting the capital utilization rate, causing the short-term fiscal multiplier to be still greater than 1, but the mid- and long-term multiplier to be smaller than 1. This result cannot fully explain the empirical finding that the long-term multiplier is significantly greater than 1 and greater than the short-term multiplier.

When the channel of capital utilization rate is closed, the fiscal multiplier is smaller than 1 no matter in the short- or long-term in the absence of monetary policy coordination. When, γ_g>0, the fiscal multiplier is greater than 1 irrespective of whether the channel of capital utilization rate exists, and the long-term multiplier is greater than the short-term multiplier. As such, capital cost cannot fully explain the phenomenon that China's fiscal multiplier is greater than 1 in both the short-term and the long-term, and is not a necessary condition for our benchmark model to generate a fiscal multiplier greater than 1.

To investigate the theoretical mechanism of the above results, Figure 2 shows the impulse responses of inflation, nominal interest rate and real interest rate. As can be seen from the chart, when the monetary policy increases money supply in coordination with fiscal expansion, inflation will increase more sharply compared with the scenario of monetary policy independence. By increasing aggregate demand, government spending gives rise to a certain degree of inflation, and when monetary policy increases money supply in coordination with fiscal expansion, the increase in nominal interest rate becomes smaller than the rise of inflation, causing real interest rate to fall. Whether or not there is a reduction of real interest rate is a critical factor for fiscal expansion to create a crowding-in effect or crowd-out effect for private consumption. When real interest rate decreases, the intertemporal substitution effect outweighs the negative effect, causing expansionary fiscal spending to drive consumption in the private sector.

In addition, due to increasing seigniorage from the money supply expansion, the lump-sum tax or debt burden resulting from fiscal expansion will decrease, thus diminishing the negative wealth effect and enhancing the fiscal policy's economic stimulus effect. In the absence of monetary policy coordination, nominal interest rate will increase at a faster pace than inflation, causing real interest rates to rise. Moreover, taxation or government debt financing will also exert a significant negative wealth effect. The negative wealth effect, coupled with rising real interest rate, will crowd out household consumption and inhibit inflation. In other words, under the scenario of monetary policy coordination, while the interaction between fiscal spending and monetary policy causes real interest rate to decline, increasing seigniorage will ease the negative wealth effect of fiscal expansion. Their superimposed effects drive household consumption and thus create a significant economic stimulus.

Notably, this transmission mechanism is similar to the fiscal policy being able to hold down real interest rate and generate a significant multiplier effect when the nominal interest rate is restricted by the ZLB as put forth by Woodford (2011), Christiano *et al*. (2011), Dupor and Li (2015), *et al*. Unlike the above research literature, this paper introduces the coordination of monetary policy to fiscal policy found in empirical research without the ZLB effect to be more consistent with China's reality. Existing empirical studies (e.g. Wang and Wen, 2018; Zhang *et al*., 2019; Li and Zhou, 2021; Li and Li, 2018) all found China's fiscal multiplier to be greater than 1.

5.2 Sensitivity Analysis

In the above transmission mechanism, monetary policy coordination contributes to fiscal policy effectiveness in the following ways: First, synchronous monetary policy expansion is conducive to driving household consumption by magnifying the inflationary response and inducing a decrease in real interest rate; second, money supply will reduce the negative wealth effect arising from the one-off total taxation and government debt by increasing seigniorage. As a further improvement of the discussions, this section will analyze the effects of other possible factors on the fiscal policy transmission mechanism. Specifically, a sensitivity analysis is performed from such perspectives as the continuity of fiscal expansion, the response of fiscal spending to output and debt, and the complementarity between private consumption and government consumption. Furthermore, this paper has also examined the effects of price and wage stickiness, financial friction and other factors (e.g. Bernanke *et al*., 1999; Christensen and Dib, 2008; Yuan *et al*., 2011) on the transmission mechanism.

(1) Persistence of fiscal spending shock (ρ_g). For fiscal shocks of the same magnitude, their economic stimulus effect varies depending on whether those shocks are absorbed into the economy

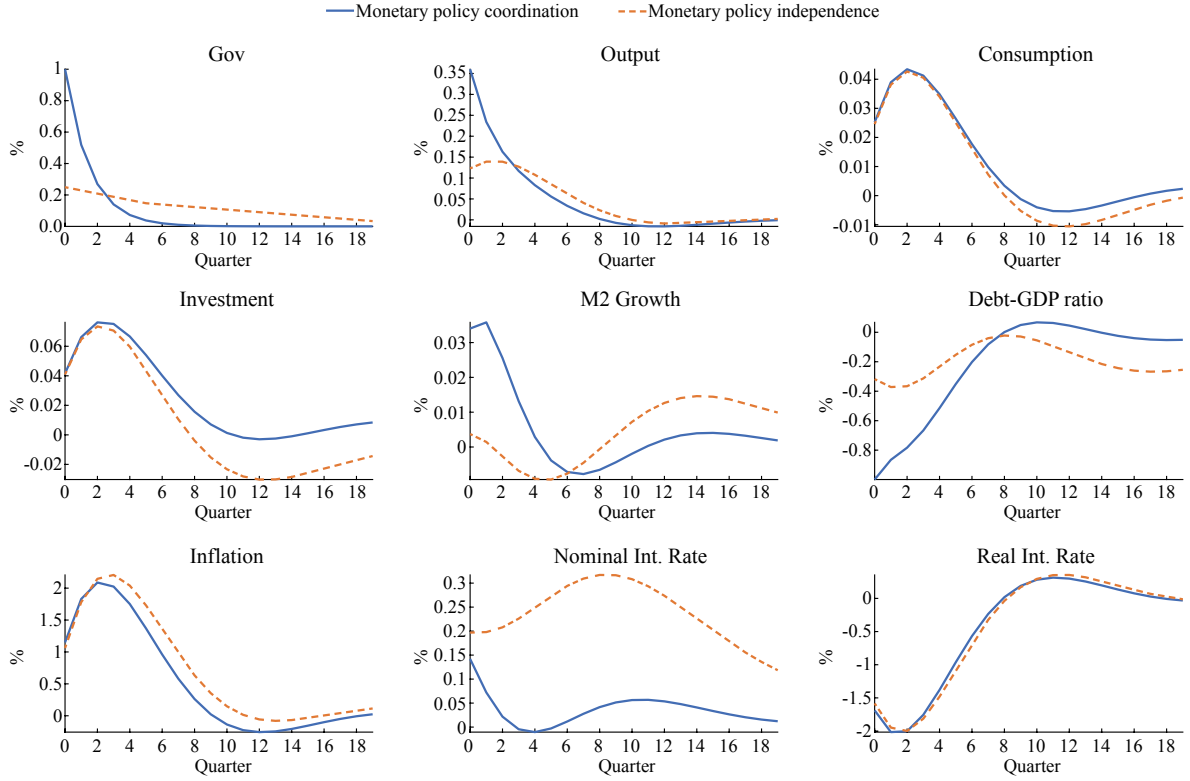

Figure 3: Impulse Response Functions with Different Persistence of Fiscal Spending Shocks

swiftly or continuously yet slowly. The reason is that in our model, the variable affecting monetary policy expansion is change in fiscal spending in the current period ($\hat{g}_t$) rather than the aggregate scale of change in fiscal spending throughout the entire expansionary cycle ($\sum_{t=0}^{\infty}\beta^t\hat{g}_t$). Figure 3 compares the impulse response functions of the model with a high persistence of fiscal spending shock (ρ_g=0.9) and the benchmark model. To ensure the same magnitude of fiscal stimulus under the two scenarios, this paper has adjusted the initial value of fiscal shocks to obtain identical present values of fiscal expansion under both circumstances ($\sum_{t=0}^{\infty}\beta^t\rho_{g1}^t g1=\sum_{t=0}^{\infty}\beta^t\rho_{g2}^t g2$).

As can be seen from Figure 3, for the same scale of fiscal stimulus, its economic stimulus effect is subdued if it is released into the economy persistently but slowly. This paper may find the reason from the impulse response of money supply. Since the level of fiscal expansion is relatively small in the current period, motivation for a monetary policy expansion is weak; to keep price stability, there is an even stronger motivation for a monetary policy contraction when inflation goes up. These two forces may jointly find expression in a monetary policy contraction. Since monetary policy still responds to a fiscal policy expansion, the contraction of money supply remains smaller than what it takes to hold down inflation. As such, real interest rate will still decrease, albeit to a lesser degree. Household consumption is driven up by the falling real interest rate, thereby creating a significant economic stimulus effect, which is nonetheless smaller than the benchmark result.

(2) Response of fiscal spending to output and debt. Not only is fiscal spending continuous, it also adjusts to such variables as output and government debt. This feedback mechanism may cause a fiscal spending reversal in the mid-term after a short-term fiscal stimulus, i.e. fiscal spending falls below the long-term trend as to influence the policy effect of a fiscal stimulus (Corsetti *et al*., 2012). To avoid the potential interference of fiscal spending reversal with the transmission mechanism in our model, the

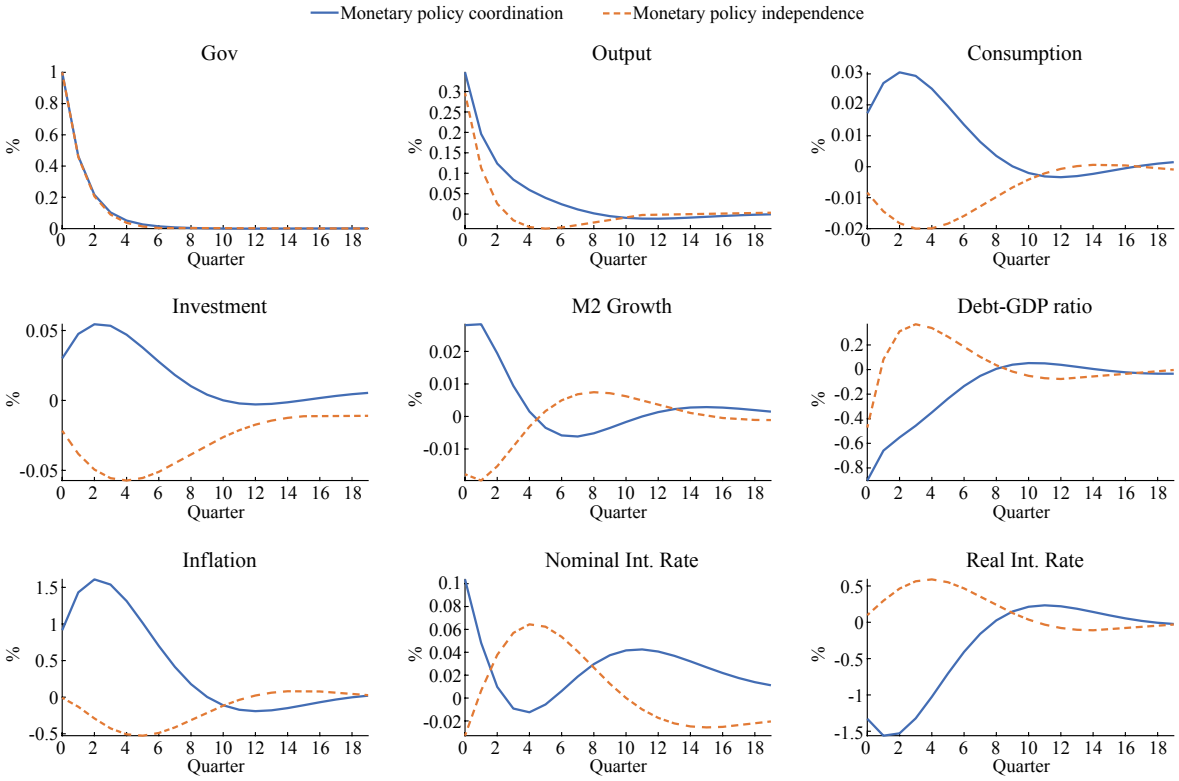

Figure 4: Impulse Response Function after the Adjustment of Fiscal Spending Rule

benchmark model does not include the feedback of fiscal spending to other economic variables. In this section, the above feedback mechanism is included to examine the robustness of the benchmark model. Specifically, this section considers the linearized fiscal spending rule in the following form:

$$\hat{g}_t=\rho_g\hat{g}_{t-1}-(1-\rho_g)(\varphi_y\hat{y}_{t-1}+\varphi_b\hat{b}_{t-1})+\varepsilon_t^g$$

Where, φ_y and φ_b denotes the levels of response of fiscal spending to output and government debt. After this attribute is introduced, this paper employs the Bayesian approach to re-estimate[4] relevant model parameters and provide the impulse response function of fiscal spending.

As can be seen from Figure 4, after introducing the rule for the feedback of fiscal spending to output and the government debt, monetary policy coordination remains an important condition for fiscal spending shocks to drive private consumption and investment. Despite numerical differences in the impulse response functions of variables compared with those of the benchmark model, their directions are consistent and in line with the transmission mechanism in the benchmark model. Hence, the transmission mechanism in the benchmark model of this paper remains robust after introducing the feedback rule for fiscal spending.

(3) Complementarity between private consumption and government consumption. Bouakez and Rebei (2007) and Wang and Tian (2014) consider the complementarity between private consumption and the government consumption as a key attribute in the research of the fiscal multiplier. After introducing the complementarity between private and government consumption, an increase in fiscal spending may boost the marginal utility of private consumption, thus giving rise to the crowding-in effect of

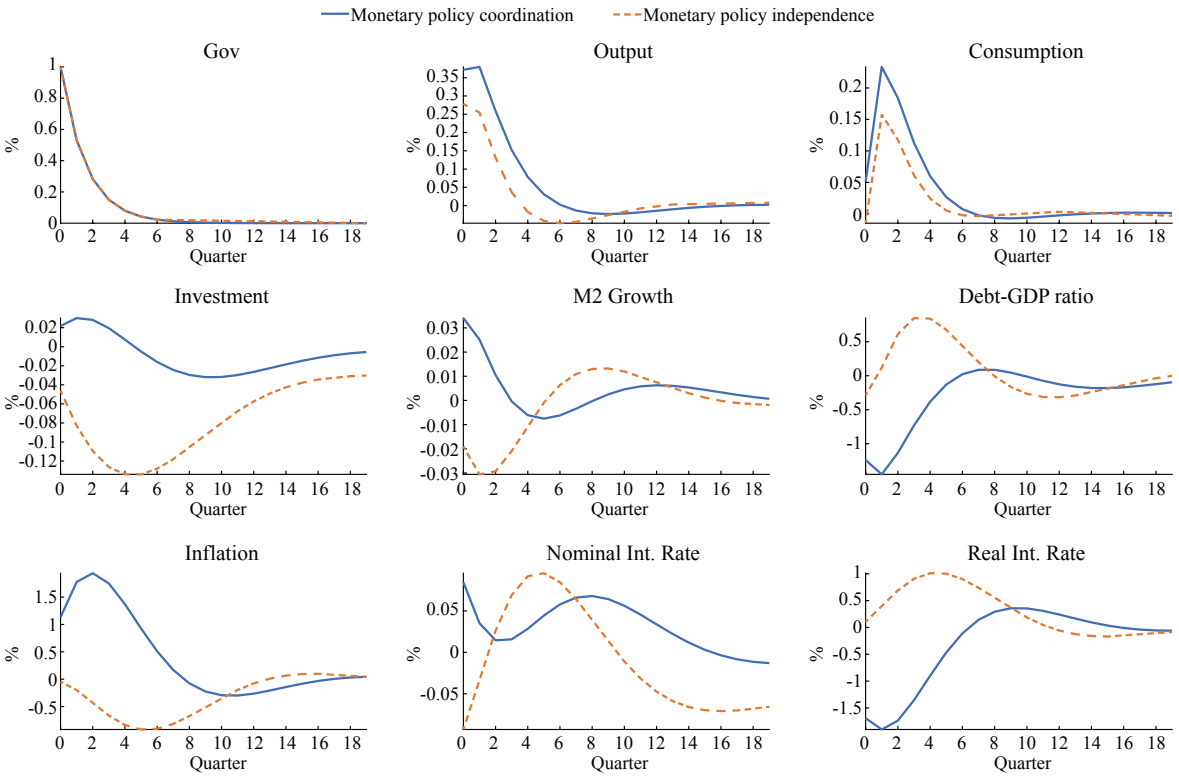

Figure 5: Impulse Response Functions after Introducing Complementarity between Private and Government Consumption

[4] For prior distribution of φ_y and φ_b, please refer to Leeper et al. (2010).

government consumption on private consumption. This section examines whether the above conclusions remain the same after introducing such complementarity. Specifically, aggregate consumption of the following form $\widetilde{c}_t$ is introduced according to Bouakez and Rebei (2007):

$$\widetilde{c}_t = [\psi(c_t)^{\frac{v-1}{v}} + (1-\psi)(g_t)^{\frac{v-1}{v}}]^{\frac{v-1}{v}}$$

Where, $\widetilde{c}_t$ is the aggregate consumption with a constant elasticity of substitution, c_t is private consumption, and g_t is government consumption. $v \in (0, \infty)$ denotes the elasticity of substitution between private consumption and government consumption, and ψ is the weight of private consumption, which is specified as 0.8 in this paper. When $v \to 0$, private consumption and government consumption are fully complementary with each other, and when $v \to \infty$, private consumption and government consumption become complete substitutes. According to Bouakez and Rebei's (2007) research conclusions and this paper's utility function specification, when $v < 1$, the marginal utility of private consumption will increase with the growth of government spending. This paper specifies this parameter to be 0.5[5].

After introducing the complementarity between private and government consumption, this paper employs the Bayesian approach to re-estimate relevant model parameters and provides the impulse response function of fiscal spending. As can be seen from Figure 5, under the scenario of policy independence, an increase in government spending may also drive household consumption, which is consistent with research literature. After introducing monetary policy coordination, the crowding-in effect of fiscal spending becomes magnified, further increasing total output growth. The reason is that with monetary policy coordination, real interest rate becomes subdued, creating an additional crowding-in effect via the the intertemporal substitution effect. Obviously, the transmission mechanism in this paper's benchmark model remains robust after introducing the complementarity between private and government consumption.

6. Conclusions and Policy Implications

Most existing empirical studies have found that China's fiscal spending multiplier to be greater than 1 and the crowding-in effect of fiscal policy to be significant. This phenomenon, however, cannot be explained with a standard macroeconomic model. The economics community, therefore, has to revise the standard model to make it better positioned to explain this economic phenomenon. However, existing theoretical developments either require strong assumptions or are inconsistent with China's reality and cannot explain China's economic phenomenon. As such, there is an urgent need for Chinese economists to put forth a theoretical explanation consistent with China's reality with respect to the large fiscal multiplier, i.e. fiscal policy has a significant crowding-in effect. Such work is of great significance to not only advancing the development of economic theories, but assisting policymakers in clarifying the policy transmission mechanism, identifying the right policy combination, and enhancing the quality and effectiveness of proactive fiscal policy.

First, this paper simultaneously incorporates monetary and fiscal policies into the SVAR model to examine whether the monetary policy is coordinated with or independent from expansionary fiscal spending. Both short-term and long-term identification assumptions are imposed to identify exogenous fiscal spending shocks. Meanwhile, the current period impact of monetary policy variable on inflation is maintained to stay consistent with economic theories and the reality. Results of empirical analysis suggests that the monetary authority adopted an expansionary monetary policy in coordination with fiscal policy expansions. As found in the subsequent robustness analysis, results of empirical research are robust no matter when the number of lags of the model is adjusted or government consumption and

[5] To investigate the robustness of results, this paper attempted different values of this parameter and found the main conclusions to be constant.

government investment are considered separately.

Based on the empirical findings, this paper modifies the DSGE model to analyze the economic stimulus effect and transmission mechanism of fiscal policy in the presence of monetary policy coordination. The impulse response analysis of fiscal spending shocks finds that in the presence of monetary policy coordination, fiscal policy may drive household consumption and investment, thereby expanding total output and achieving a significant economic stimulus effect. The transmission mechanism is as follows: When fiscal spending expands, the monetary authority will also ease money supply, and such a monetary policy response will not only increase seigniorage and ease the negative wealth effect of physical expansion, but also inhibit nominal interest rate hike while creating a moderate inflation to bring down real interest rate and drive household consumption. In the sensitivity analysis, this paper discusses the response of fiscal spending to output and debt, the complementarity between private consumption and government consumption, and the impact of continuity in fiscal spending shocks on fiscal policy effectiveness. With such factors as price and wage stickiness and financial frictions taken into account, our transmission mechanism remains robust.

Similar to the view in the traditional theory that the degree of monetary policy counter-cyclicality will significantly affect fiscal policy effectiveness, this paper further demonstrates the importance of fiscal and monetary policy coordination. By influencing money supply and the real interest rate, fiscal policy exerts an impact on monetary policy and economic growth. In response, monetary policy will contribute to fiscal policy effectiveness and enhance the economic stimulus effect of government spending, not least on the increase of output. Notably, monetary policy coordination mentioned in this paper is not the so-called "monetization fiscal deficit," which refers to the relaxation of fiscal discipline in disregard of government long-term budgetary constraint. In this paper, both fiscal and monetary authorities should follow their respective budgetary constraints. By increasing money supply in a market-based way during a fiscal spending expansion, the monetary authority achieves the goal of enhancing fiscal policy effectiveness.

This paper's research conclusions provide an approach to improve the quality and effectiveness of a proactive fiscal policy, as well as a constructive reference for implementing a more sustainable proactive fiscal policy. In practice, macroeconomic regulation achieves desired policy effects by means of not just fiscal or monetary policy alone, but requiring close coordination between the two.

Yet due to inconsistent policy goals - not least the emphasis of monetary policy independence by Western countries, monetary and fiscal authorities often cannot act in lockstep and often act in conflict. Unlike Western countries, China's institutional strength lies in the fact that both monetary and fiscal authorities are under the State Council and jointly contribute to the policy goals of ironing out economic volatility and promoting sustained and health economic development under the leadership of the CPC Central Committee.

Over the years, China has continuously implemented a combination of proactive fiscal policy and prudent monetary policy. While the proactive fiscal policy maintains a proper spending intensity and beefs up fiscal strength, the prudent monetary policy aims to bring the growth rates of money supply and social financing aggregate in line with nominal economic growth rates. A moderate increase in money supply amid economic growth under the proactive fiscal policy is an intended result of this policy combination, for which this study offers a theoretical justification.

Our study leads to the following policy recommendations:

(1) the central government should fully leverage China's institutional strength in policymaking, coordinate the policies and interests of various departments, give full play to synergy between fiscal and monetary policies, enhance the regulatory intensity of policy measures, and establish linkages between fiscal and monetary policies for high-quality economic development in the new era.

(2) While implementing the monetary policy, the central bank should balance the objectives of short-term inflation and output gap with long-term economic growth targets to coordinate with fiscal

policy implementation, improve the design of intertemporal macroeconomic regulation, and combine short-term regulation with long-term development. It needs to work together with the fiscal authority to promote high-quality and stable economic development.

(3) The fiscal authority should maintain sufficient communication with the monetary authority, take resolute actions when the economy shows signs of slowdown, and achieve the policy goal of stimulating the economy and managing economic volatility by working closely with the central bank. In the presence of policy coordination from the monetary authority, the proactive fiscal policy can become more effective and sustainable, offering a reasonable and effective policy combination for high-quality development under the new development paradigm.

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